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VERTICAL INTEGRATION, MARKET FORECLOSURE AND QUALITY INVESTMENT *

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Keywords: L1, L4, L5, L13 .

JEL Classification: Vertical Differentiation, quality investment, foreclosure, production costs

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Vertical Integration, Market Foreclosure and Quality Investment

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Abstract

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1 Introduction

An important aspect of any oligopolistic market structure is investment in long run variables such as quality, R&D, or advertising (Sutton, 1991). The focus of most models has been the impact of vertical integration on product costs and market competitiveness, in horizontal product differentiation models. The impact of such practices on long run variables such as quality, or R&D has mostly been ignored (with the exception of Stefanadis (1997), Banerjee and Lin (2003) and Brocas (2003) who look at R&D). In this paper we show that while the direct affect of vertical integration and foreclosure is an increase in production costs, it subsequently affects investment in quality for both the integrated and the non-integrated firm. While both the firms decreases quality investment, the non-integrated firm decreases its quality investment by a greater amount. The final effect of this is an increase in product differentiation resulting in softening of competition[1].

The literature on vertical integration, as a strategic decision affecting competition[2], has focussed on mergers between input and output producers. The analyses has focussed on conditions under which vertical integration and foreclosure takes place, and when they can be welfare increasing. While little has been said on the effect of investment in long run variables such as quality, or R&D. Some recent papers have looked at R&D in vertically related industries. Stefanadis (1997) studies the effect of R&D investment in a successive duopoly[3]. In his model firms integrate strategically to reduce the incentives of the non-integrated upstream firm to invest in R&D. This is achieved through a reduction in demand for the input, subsequently obtaining a advantageous position in the final goods market. Banerjee and Lin (2003) study the effect of downstream innovation in vertically related markets. By increasing demand for the input, downstream R&D increases the price for the downstream firm. This lowers the benefit to R&D to the downstream firm plus it raises rivals' costs. Due to this, the downstream oligopolist invests more in R&D than a monopoly does. Brocas (2003), meanwhile, studies innovation in the upstream market. Adopting a new technology has a switching cost. Prices of licenses, for the technology, vary with this cost. Easily substitutable technologies command a low price and innovators benefit from a lock in effect for technologies with high switching costs. More importantly the price affects

[1] This results does not hold when firms merge simultaneously in the first stage. As one expects the strategic motive of raising rivals costs, which is the focus of most papers, is lost in simultaneous vertical mergers.

[2] See Ordover, Saloner and Salop (1990), Hart and Tirole (1990).

[3] In his model there are several firms that supply the input. However, only two of them invest in R&D to obtain the new technology.

the ex-ante private incentives to invest in R&D resulting in the disappearance of efficient technologies with low (switching) costs. In such a framework innovators and producers may find it profitable to integrate vertically before investing.

We develop a simple model that looks at the relationship between vertical integration and market foreclosure in vertically differentiated industries. Using the same industry structure as in Ordover, Saloner and Salop (1990, OSS henceforth) we show that partial, or full, sequential integration results in a decrease in quality investment by both the low and high quality firm. Interestingly, a vertically integrating firm affects both production and quality costs for its non-integrated rival. In our model a firm integrating first always earns greater profits. Considering only sequential vertical mergers the equilibrium market structure obtained is full integration where, total welfare is greater than under no, or partial, integration.

Integration between an upstream and a downstream firm is a strategic decision as it affects rival profits and the market structure. The decision of the integrated firm to not sell the input to its rival has two effects in our model. First, it decreases competition in the upstream market resulting in increased production costs for the downstream rival[4]. The second important effect in our model is observed upon quality investment. Note that, the unintegrated firms' quality investment decision is also conditioned by the higher production costs that it faces. Increased production costs negatively affect quality investment by the unintegrated firm. Given that the low quality firm has less incentives to invest in quality results in the high quality firm investing less too. The decrease in quality investment, however, is *greater* for the unintegrated low quality firm. Due to this, the degree of product differentiation increases. If the low quality firm integrates first then no equilibrium in pure strategies exists (in which the low quality continues producing the low quality good). In this case leapfrogging is observed resulting in the low quality firm becoming the high quality producer.

The paper is organized as follows. In the following section we describe the basic model. Following this we study several different market structures. Then we analyze the industry structure in equilibrium. The last section concludes.

[4]The effect of reducing competition in the output stage by increasing input costs has been studied by Salop and Scheffman (1983, 1987).

2 The model

Consider a successive duopoly where two upstream firms (U_1 and U_2) produce a homogenous good at constant marginal costs. The input is transformed one-to-one by the downstream firm into a final good. The final product is vertically differentiated. Goods of quality s_1 and s_2 are obtained after the firms invest in quality. Let us denote s_1 as the high, and s_2 as the low, quality good, such that $s_1 > s_2$[5]. Production cost for the final good, q_i, are given by,

$$C_{D_i}(s_i, q_i) = c_i \cdot q_i + \frac{1}{2}s_i^2, i = 1, 2 \tag{1}$$

where c_i is the input price.

Production costs are independent of quality costs. Note that quality costs are endogenous and are sunk in the output competition stage. Costs of production for the upstream firm U_i are given by $C_{U_i}(X_i) = c_U X_i$, where c_U is the unit production costs for the input. Without loss of generality we assume that marginal costs of production, $c_{U,}$ are zero for both the upstream firms.

Assume that a continuum of consumers exist on the demand side[6]. Each consumer has parameter θ, where θ is distributed uniformly in the interval $[0, \bar{\theta}]$. Consumers have unit demand and have utility,

$$U = \begin{cases} \theta s - p & \textit{purchasing one unit of the good with quality } s \textit{ and price } p \\ 0 & \textit{otherwise} \end{cases}$$

We denote by $\hat{\theta}_{12} = \frac{p_1 - p_2}{s_1 - s_2}$ as the consumer that is indifferent between consuming the high and the low quality good. Similarly the consumer indifferent between consuming the low quality good and not consuming at all can denoted by $\hat{\theta}_{02} = \frac{p_2}{s_2}$. Given this, the indirect demand functions are obtained for the high and low quality good, respectively:

$$p_1 = s_1(\bar{\theta} - q_1) - s_2 q_2 \tag{2a}$$
$$p_2 = s_2(\bar{\theta} - q_1 - q_2) \tag{2b}$$

where q_1 and q_2 are the quantities produced by the high and low quality downstream firms, respectively.

[5] See Shaked and Sutton (1983).

[6] We use the standard product differentiation developed in Shaked and Sutton (1983). Also see Motta (1993).

We consider a five stage game (see *figure 1*). In the first stage (and maintaining the OSS notation), the downstream firm, D_1 and D_2, negotiate with the upstream firms, U_1 and U_2, to integrate or not. Simplifying the process and to maintain comparability with OSS we assume that firms D_i make a *take it or leave it* offer, b_i, to firms U_i, $i = 1, 2$[7]. Firm D and U merge to form a single firm F[8].

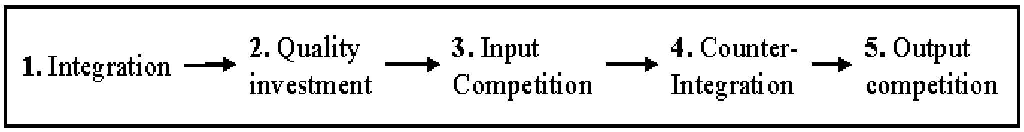

Figure 1: Stages

In the second stage, firms D_1 and D_2, or the integrated firm(s), select profit maximizing levels of quality. In the third stage, the upstream firms, integrated or not, select the price at which they sell the input. We assume Bertrand competition in the input market[9]. If both the upstream firms compete then the price in equilibrium equals marginal cost. Similarly, the price would be the same if an integrated, and unintegrated, firm compete in the input market. This eliminates the strategic incentives to integrate (and increase rival costs). We assume that the integrated firm does not sell the input to its rival, focusing instead on the case of market foreclosure on the part of the integrated firm. Market foreclosure leaves its rival acting as a monopolist against the unintegrated downstream firm.

However, the unintegrated firm can integrate in the fourth stage. The integration process is the same as in the first stage. That is, the unintegrated firm D makes a *take it or leave it* offer to the (unintegrated) U firm. If the latter accepts, then they integrate forming firm F. A firm integrating first decides on its strategy taking into account that its rivals are not integrated. This clearly affects the quality investment decision and, those made in the output and the input markets. Unintegrated firms can contraintegrate later, thus restoring the initial situation. However, as contraintegration occurs after

[7] One can formulate the bidding at this stage in several ways. One can use the structure in OSS, which we also use. OSS then study the robustness of their results with two different formulations. In one, upstream firms bid and in the other the downstream firms bid for the two upstream firms. Their main results do not change. Only the bids and the distribution of profits is different in the first case.

[8] Given the symmetry of the upstream firms we denote the integrated firm, between D_i and U_i, as F_i

[9] The advantage of price competition is that it isolates the problem of the strategic value of vertical integration for the integrating firm. For a greater discussion see OSS.

quality investment, competition in qualities results in different qualities. As a consequence, output and prices are different from when no integration occurs. Finally in stage five the firms compete in quantities.

Depending on how firms vertically integrate we can have six possible market structures. First is the case of no integration (NI). We then have two cases of partial integration (PI_i), where only one of the firms integrates in the first stage of the game. Then we have two cases of Full Sequential Integration (FI_i). In this case one of firms integrates in the first stage while the other integrates in the fourth stage[10].

In the following section we obtain the quality, output and prices for each one of the market structures mentioned above. The game is solved using subgame perfection and we study equilibria in pure strategies only. Finally we discuss the market structure that emerges in equilibrium.

3 No Integration (NI)

Assuming that no firm integrates, we first solve for outputs in the final stage. Firm D maximize profits, $\max_{q_i} \pi_i = (p_i - c_i) q_i - \frac{s_i^2}{2}$. The first order conditions give us the reaction functions

$$q_1 = \frac{s_1\bar{\theta} - c_1 - q_2 s_2}{2s_1} \tag{3a}$$

$$q_2 = \frac{s_2\bar{\theta} - c_2 - q_1 s_2}{2s_2} \tag{3b}$$

Solving for the equilibrium quantities, $q_1(s_1, s_2, c_1, c_2), q_2(s_1, s_2, c_1, c_2)$, we obtain.

$$q_1(s_1, s_2, c_1, c_2) = \frac{(2s_1 - s_2)\bar{\theta} - 2c_1 + c_2}{4s_1 - s_2} \tag{4a}$$

$$q_2(s_1, s_2, c_1, c_2) = \frac{s_1 s_2\bar{\theta} - 2c_2 s_1 + c_1 s_2}{s_1(4s_1 - s_2)} \tag{4b}$$

In the third stage of the game firms U_1 and U_2 compete in prices for the input demand $(q_1 + q_2)$. Price competition in a homogenous input gives us price equal to marginal cost in equilibrium, i.e., $c_i = 0$, $i = 1, 2$.

[10] We maintain the notation followed by OSS.

In the second stage firms choose quality levels maximizing profits, $\max_{s_i} \Pi_i = q_i(s_1, s_2, c_1, c_2) \cdot p_i(q_1(s_1, s_2, c_1, c_2), q_2(s_1, s_2, c_1, c_2)) - \frac{1}{2}s_i^2$, $i = 1, 2$. The implicit reaction functions obtained from the first order condition are

$$s_1 = \frac{(16s_1^3 - 12s_1^2 s_2 + 4s_1 s_2^2 - s_2^3)\,\bar{\theta}^2}{(4s_1 - s_2)^3} \tag{5}$$

$$s_2 = \frac{s_1^2(4s_1 + s_2)\,\bar{\theta}^2}{(4s_1 - s_2)^3} \tag{6}$$

and can be seen in *figure 2*.

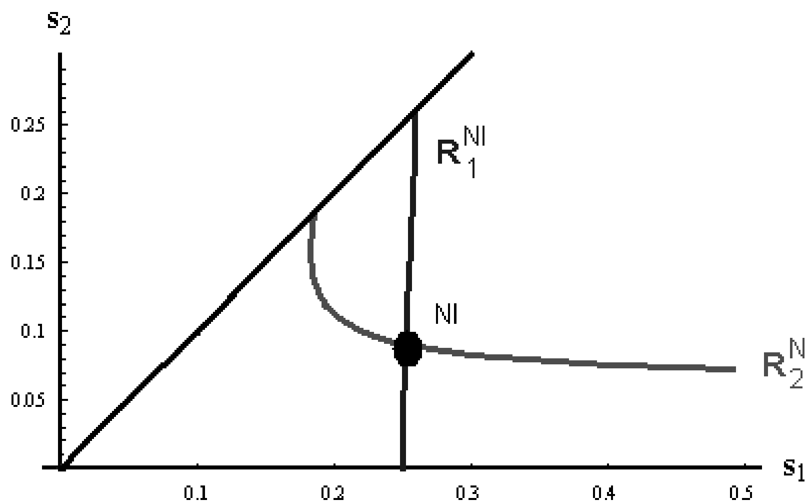

Figure 2: Quality reaction functions under No Integration.

From the first order conditions ([5] and [6]) we first numerically compute the equilibrium qualities. The quantities and profits are then obtained under NI (for details see Motta, 1993). The results are shown in *table 1*.

$s_1^{NI} = 0.251942\bar{\theta}^2$	$s_2^{NI} = 0.090223\bar{\theta}^2$
$q_1^{NI} = 0.450834\theta$	$q_2^{NI} = 0.274583\theta$
$\Pi_{U_1}^{NI} = 0$	$\Pi_{U_2}^{NI} = 0$
$\Pi_{D_1}^{NI} = 0.019470\bar{\theta}^4$	$\Pi_{D_2}^{NI} = 0.002732\bar{\theta}^4$

Table 1: No Integration.

4 Partial Integration ($\mathbf{PI}_i$)

Under partial integration only one of the downstream firm (D_i) integrates with the upstream firm (U_i). This results in a single integrated firm F_i. Using subgame perfection we first solve for the output competition stage. The output reaction functions and the equilibrium output are the same as in the NI game (see equations [3a] and [3b]). Note that, the only difference between the two is that the input price is now a transfer price for the integrated firm. We set $c_i = 0$. The non-integrated firm meanwhile faces the input price that is determined in the third stage.

The equilibrium price equals marginal cost in the input competition stage if F_i decides to sell the input to the downstream firm D_j. In this case integration does not grant any advantage to F_i. In fact, D_i loses with respect to the NI case as it incurs a cost when integrating with U_i. However, F_i can raise its rivals cost by not selling it the input. Then the rival faces a monopolist in the input market and pays a monopoly price for the input. The upstream U_j sets the input price maximizing profits, $\max_{c_j} \Pi_{U_j} = c_j \cdot q_j(c_j, s_i, s_j)$ where $q_j(c_j, s_i, s_j)$ is obtained from equations [4a] and [4b].

If both firms, D_1 and U_1, integrate, then firm U_2 sets an input price $c_2^{PI} = \frac{s_2\bar{\theta}}{4}$, maximizing profits, $\max_{c_2} \Pi_{U_2}$. However, if firms D_2 and U_2 integrate then the non-integrated firm U_1, maximizing profits $\max_{c_1} \Pi_{U_1}$, sets a price $c_1^{PI} = \frac{(2s_1 - s_2)\bar{\theta}}{4}$ for the input. The price, c_i, paid by the firms depends on whether the high, or low, quality firm integrates. It is easy to see that the price paid by the high quality firm (if low is integrated), c_1^{PI}, is greater than the price paid by the low quality firm (if high is integrated), c_2^{PI}. This is an interesting result as it tells us that the high quality firm pays a higher price for its input than a lower quality firm would.

In the second stage of the game firms F_i and D_j set qualities maximizing their profits (taking into account that firm D_j pays a price c_j^{PI} for each unit of the input it buys). The implicit reaction functions obtained from the maximization problem are plotted in *figure 3*. First notice that (see *figure 3a*) the reaction function of the integrated firm F_1 moves out and that of the non-integrated firm D_2 moves towards the origin. An integrated firm increases production costs for the non-integrated firm (as defined by Salop and Scheffman (1983 and 1987) and also obtained in OSS). The increased input price it faces D_2 (c_2^{PI}) shifts its reaction function towards the origin. The reaction function of firm D_1, however, shifts outwards due to decreased competition in the final good market (see *figure 3b*). Equilibrium qualities obtained under PI_1 are given by the intersection point of the reaction function and are:

$$s_1^{PI_1} = 0.250054\bar{\theta}^2 \quad s_2^{PI_1} = 0.016710\bar{\theta}^2 \tag{7}$$

Equilibrium output and profit are shown in *table 2*:

$q_1^{PI_1} = 0.495753\bar{\theta}$	$q_2^{PI_1} = 0.127124\bar{\theta}$
$\Pi_{U_1}^{PI_1} = b_1$	$\Pi_{U_2}^{PI_1} = 0.000531\bar{\theta}^4$
$\Pi_{D_1}^{PI_1} = 0.030192\bar{\theta}^4 - b_1$	$\Pi_{D_2}^{PI_1} = 0.000130\bar{\theta}^4$

Table 2: Only high quality firm integrates.

Leapfrogging is observed in the case where only the low quality firm integrates (PI_2). An equilibrium in pure strategies does not exist in this case. Looking at *figure 3b* one can see that the reaction functions do not intersect in the relevant range where $s_1 > s_2$. The reaction function of the low quality firm (D_2) moves out due to the cost advantage against the rival while the reaction function of the high quality firm (D_1) moves inwards. The shift is large enough such that the functions do not intersect. The only equilibrium in this case is one where the low quality firm "leapfrogs" its rival and produces the high quality good.

The only case where the equilibrium in pure strategies exists is where the high quality firm integrates first (see *figure 3a*). In this case firm, D_1 needs to make an offer to firm U_1 to vertically integrate. The offer firm U_1 is willing to accept is at least the profits it would obtain if were not to integrate. In equilibrium the offer made by D_1 exactly equals such profits, i.e. the offer $b_1 = \Pi_{U_2} = 0.000531\bar{\theta}^4$.

5 Total Sequential Integration (FI$_i$)

Now suppose that firms sequentially integrate to form two single integrated firms, $F_i\,(= D_i + U_i)$, $i = 1, 2$. The first pair of firms integrates in the first stage, while the other contraintegrates in the third stage. Contraintegration occurs after firms have set their quality investment. In the last stage, firms produce output maximizing profits (equations [4a] and [4b]).

The input can be considered as an internal transfer for the firms as they are integrated. This implies that firms do not compete in the input market. We assume that the input prices are $c_1 = c_2 = 0$.

In the third stage, the non-integrated firm D_j makes an offer, b_j, to firm U_j to integrate. The smallest amount that U_j is willing to accept is the

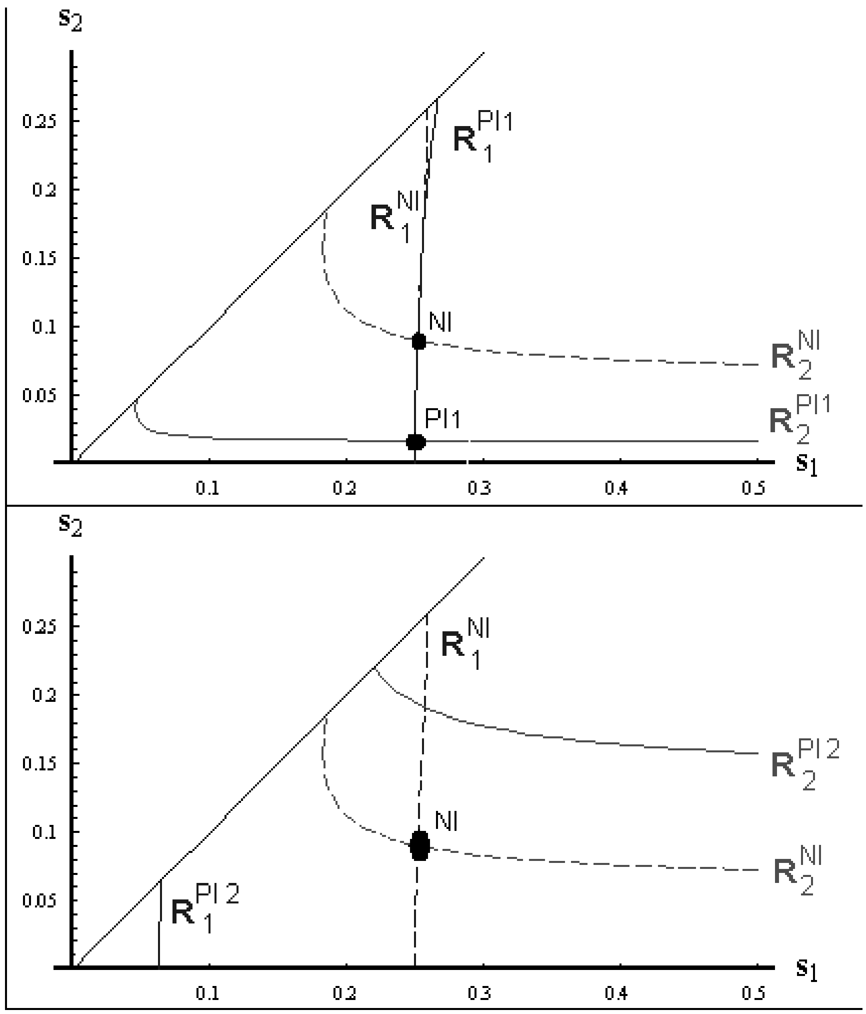

Figure 3: Quality reaction functions when only one of the firms integrates (PI). a) High quality firm intgrates (PI_1); b) Low quality firm integrates (PI_2).

profit it would obtain if it were not to integrate, i.e. $b_j = \max_{m_j} \Pi_{U_j}$, where $\Pi_{U_j} = m_j \cdot q_j(s_j, s_i, m_j, 0)$ and m_j is the price of the input set by U_j.

In stage two, the "downstream" firms choose qualities that maximize their profits. There is an integrated and an unintegrated firm in this stage. Firm, D_i, integrating in stage one, has already formed F_i (paying b_i). The unintegrated firm, D_j, meanwhile, could make an offer to counterintegrate with U_j. The counterintegration offer, b_j, is determined by the quality investment chosen in the second stage.

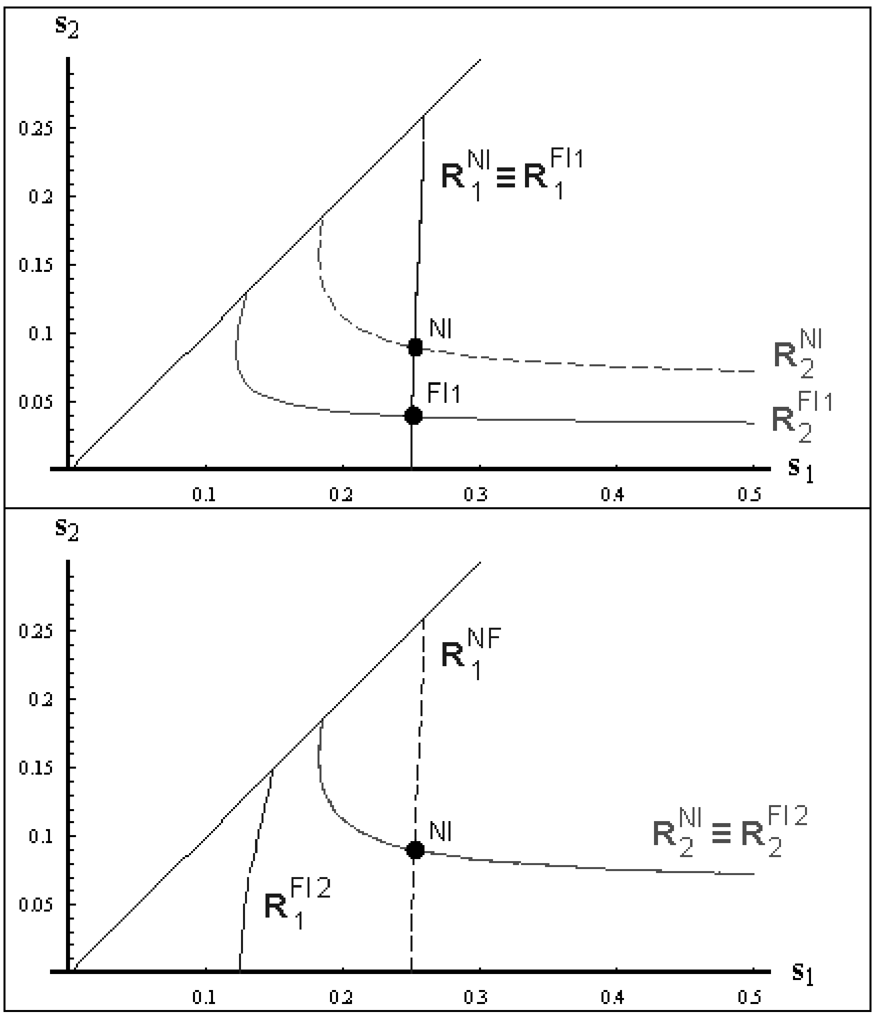

Figure 4: Quality reaction functions under Sequential Integration (FI): a) High quality firm integrates first (FI_1); b) Low quality firm integrates first (FI_2).

Once F_1 forms, the offer that D_2 makes to U_2 will be $b_2 = \frac{s_1 s_2 \bar{\theta}^2}{8(4s_1 - s2)}$.

Its profits will then be $\Pi_{D_2} = p_j(s_1, s_2) \cdot q_j(s_1, s_2) - \frac{s_i^2}{2} - b_2(s_1, s_2)$. As mentioned earlier, its optimal investment decision, s_2, is conditioned by its subsequent effect on the bid b_2, i.e., a higher s_2 implies a higher b_2. Note that the quality reaction function of firm D_2 in the second stage shifts towards the origin (see *figure 4a*). The reason behind this is that the bid D_2 makes (in the fourth stage) depends directly upon the quality it selects (in this stage). As a result the incentives to invest in quality are reduced. Comparing with the case of Partial Integration we find that, in this case, the firm that integrates first cannot raise its rivals costs (input costs are the same for both the firms). It, however, raises the price firm D_2 has to pay in order to vertically integrate at a later stage. Equilibrium qualities are given by the intersection point of the two reaction functions and are:

$$s_1^{FI_1} = 0.250385\bar{\theta}^2 \quad s_2^{FI_1} = 0.039411\bar{\theta}^2 \tag{8}$$

and output and profits in equilibrium are shown in *table 3*.

$q_1^{FI_1} = 0.479519\bar{\theta}$	$q_2^{FI_1} = 0.260241\bar{\theta}$
$\Pi_{U_1}^{FI_1} = b_1$	$\Pi_{U_2}^{FI_1} = b_2 = 0.001282\bar{\theta}^4$
$\Pi_{D_1}^{FI_1} = 0.026227\bar{\theta}^4 - b_1$	$\Pi_{D_2}^{FI_1} = 0.000610\bar{\theta}^4$

Table 3: Full Integration: High quality firm integrates first.

Now consider the case when the low quality firm integrates first forming, F_2. The offer made by firm D_1, to integrate with U_1, will then be $b_1 = \frac{(2s_1 - s_2)^2 \bar{\theta}^2}{8(4s_1 - s2)}$. The reaction function for the integrated firm F_2 is the same as the one for D_2 in the NI case[11] (see *figure 4b*). The reaction function of the non-integrated firm, D_1, shifts towards the origin. This shift is due to the fact that a higher quality increases the offer that it makes at a later stage. Obviously, a higher offer decreases its profits. As a result, the reaction functions of the two firms do not cross. Once more, an equilibrium in pure strategies does not exist for the case where the low quality firm integrates first (case FI_2). The only equilibrium in pure strategies in this case is one where the low quality firm leapfrogs and produces the high quality good.

Finally, for the case FI_1, the offer made by firm D_1 that U_1 accepts is $b_1 = \Pi_{U_2}^*$, i.e., $b_1 = 0.001282\bar{\theta}^4$.

[11] Using the same reasoning as in the FI_1 case.

6 Industry Structure in Equilibrium

The literature on vertical integration focuses on sequential integration[12] as a strategic decision against non-integrated rivals[13]. One of the important results of this paper is that in the same structure as OSS and without the possibility of setting a reserve price. The equilibrium values obtained are not the same as in the NI case. Comparing with NI, input producing firms earn positive profits. The profits of the downstream firm that integrates first increase while the profits of the downstream firm that integrates later decrease. The reason behind our results is that the decision to vertical integration implies a fixed cost in terms of quality and output for the firm that integrates first. For the firm that integrates later it is different. Its quality investment directly influences the offer it makes to vertically integrate. The low quality firm decreases its investment so as not to punish itself later (as it increases its bid). Meanwhile, the high quality firm best responds by decreasing its quality. Due to this, quality investment for both the firms decreases, with the decrease for the low quality firm being of a greater magnitude. The degree of product differentiation, measured as a ratio of the two qualities[14], increases from $\frac{s_2}{s_1} = 0.36$ (under NI) to $\frac{s_2}{s_1} = 0.16$ (under FI_1). Given that its rival endogenizes the cost of integration (thereby decreasing competition in qualities), vertical integration permits the firm that integrates first to attain profits closer to the monopoly level.

Our result differs from OSS if one does not consider the reserve price assumption they make. They obtain total integration with the equilibrium values for price and output not changing. Note that, a redistribution of profits does take place in their case with the profits for the downstream firms decreasing by the same amount as the profits for the upstream firms increase. Under sequential integration, the game in OSS resembles a prisoners dilemma where both firms want to integrate. Integration, in their model, decreases profits for both the firms. Our structure is, however, different. The firm that integrates first earns greater profits. The firm that integrates in the subsequent stage, meanwhile, decreases its profits having made its quality investment decision before integrating. The main feature of our model is the

[12] There are other models that do not analyze the strategic incentives to vertically integrate. These models focus on industry structure obtained due to vertical integration, the incentives to foreclose and its effect upon social welfare. These aspects have been studied by Salinger (1988), Gaudet and Van Long (1996), Avenel (1997), Abiru et al. (1998) and Higgins (1999).

[13] See OSS and Church and Gandal (2000) for a detailed discussion.

[14] Motta (1993) defines $\lambda = \frac{s_2}{s_1}$ as the degree of product differentiation. $\lambda = 1$ implies that the goods are perfect substitutes and $\lambda = 0$ implies maximum differentiation.

fact that investment in quality is a long run variable. Integrating first, a firm is able to increases its profits and the costs of its non-integrated rival. Both the production (as in OSS and other similar models) and quality costs for the non-integrated rival, meanwhile, increase. The effect of the increase in quality investment in our model is similar to reserve price that OSS use (exogenously) to obtain foreclosure.

7 Welfare analysis

Consumer surplus can be written as:

$$CS_1 = \int_{\bar{\theta}}^{1} (\theta s_1 - p_1) d\theta \quad CS_2 = \int_{\underline{\theta}}^{\bar{\theta}} (\theta s_2 - p_2) d\theta \tag{9}$$

where the first and the second expression give us the consumer surplus for the high, and low, quality consumers, respectively. Substituting [4a] and [4b] in [10] we obtain $CS_1(c_1, c_2, s_1, s_2) = \frac{\left((2s_1 - s_2)\bar{\theta} - 2c_1 + c_2\right)\left[s_1(2s_1 + s_2)\bar{\theta} - 3s_1c_2 - 2c_1(s_1 - s_2)\right]}{2(4s_1 - s_2)^2}$ and $CS_2(c_1, c_2, s_1, s_2) = \frac{\left(s_1 s_2 \bar{\theta} - 2c_2 s_1 + s_2 c_1\right)^2}{2s_2(4s_1 - s_2)^2}$. Total consumer surplus, CS, can be written as the sum of the two, which is:

$$CS = \frac{\left((2s_1 - s_2)\bar{\theta} - 2c_1 + c_2\right) s_2 \left[s_1(2s_1 + s_2)\bar{\theta} - 3s_1c_2 - 2c_1(s_1 - s_2)\right] + \left(s_1 s_2 \bar{\theta} - 2c_2 s_1 + s_2 c_1\right)^2}{2s_2(4s_1 - s_2)^2} \tag{10}$$

Defining total welfare (TW) as the sum of firm profits and consumer surplus we can write:

$$TW = CS + \sum_{i=1}^{2} \left(\Pi_{D_i} + \Pi_{U_i}\right). \tag{11}$$

Total welfare for the cases analyzed before are presented in *table 4*. Firms would gain globally if only the high quality firm were to integrate. Note that, this outcome only benefits the high quality firm. The low quality firm obtains greater profits under NI and the input producers maximize profits under FI_1. Total profits increase when firms integrate sequentially. This is due to the softening of competition in this case.

For consumers it is best if firms do not integrate, or integrate simultaneously[15]. Under FI_1, where vertical integration influences long run variables, total consumer surplus decreases overall, and by a greater amount for the low quality consumers.

[15] Note that under simultaneous integration only profit redistribution takes place with total welfare remaining the same.

	NI	PI_1	FI_1
$\Pi_{U_i}, \quad i=1,2$	0	$0.00053\bar{\theta}^4$	$0.00128\bar{\theta}^4$
Π_{D_1}	$0.01947\bar{\theta}^4$	$0.02966\bar{\theta}^4$	$0.02494\bar{\theta}^4$
Π_{D_2}	$0.00273\bar{\theta}^4$	$0.00013\bar{\theta}^4$	$0.00061\bar{\theta}^4$
$\sum_{i=1}^{2}(\Pi_{D_i}+\Pi_{U_i})$	$0.02220\bar{\theta}^4$	$0.03085\bar{\theta}^4$	$0.02812\bar{\theta}^4$
CS_1	$0.03677\bar{\theta}^4$	$0.03178\bar{\theta}^4$	$0.03370\bar{\theta}^4$
CS_2	$0.00340\bar{\theta}^4$	$0.00014\bar{\theta}^4$	$0.00133\bar{\theta}^4$
CS	$0.04017\bar{\theta}^4$	$0.03192\bar{\theta}^4$	$0.03504\bar{\theta}^4$
TW	$0.06238\bar{\theta}^4$	$0.06277\bar{\theta}^4$	$0.06316\bar{\theta}^4$

Table 4: Profits, Consumer Surplus and Total Welfare.

OSS show that the possibility to vertically integrate does not affect the society globally. Total welfare is the same under NI and FI. This result is obtained in our model only if the firms integrate simultaneously[16]. However, in our model if firms integrate sequentially (FI_1) then Total Welfare is greater than under no integration (NI). This increase is due to the increase in profits for the input producing and the high quality firm.

8 Conclusion

In this paper we have studied the incentives to vertically integrate in vertically differentiated industries. An important aspect of such models is that firms invest in long run variables such as quality. Taking into account endogenous investment in quality we observe that vertical integration by a firm does not only increase production costs for the rival. Vertical integration also changes the incentives to invest in quality for both the firms. The high quality firm integrating first, increases the costs for the unintegrated downstream rival. This increase is not directly an increase in quality costs, instead, increased quality investment is reflected in the increased offer it has to make to counterintegrate later. Increasing rival production costs, an integrated firm is able to decrease quality investment for both the firms. Our paper points out the importance of taking into account investment in long run variables in such industries. To our knowledge, ours is the first paper to point out the negative effect on quality investment due to vertical integration.

Analyzing sequential mergers we find that the market that maximizes

[16] OSS only consider sequential integration. Allowing for simultaneous integration in their model one obtains a totally integrated industry (as in our case).

social welfare is Full Integration. The firm that merges first increases its profits while the firm that merges later on earns lower profits. Total welfare under this case is greater than under No-Integration.

The main difference between our paper and OSS is that they limit their analysis to short run variables such as output and price. In their model, a firm paying a price greater than marginal cost is able to offset this by vertically integrating. Both then face the same conditions in the output competition stage. This is, however, not the case in our model where quality investment is sunk when the firm integrates in the following period. In our model, contra-integration does not restore the initial conditions. The firm that integrates later obtains lower profits. This is due to the fact that an increase in quality implies a higher offer that a firm has to pay later on to integrate. As a result, firm investment in quality decreases relative to No-Integration. The high quality firm takes advantage of this situation, investing less in quality and increasing its profits.

The result obtained in OSS is a partially integrated industry, where the integrated firm sells the input to its rival at a "reserve price" such that the rival's profits with, or without, integration are the same. This aspect of their model has been criticized in the literature as it is not an equilibrium of the game they study[17]. Without the possibility of the reserve price, the result in their model resembles a prisoners dilemma, where the industry is totally integrated. Price and output obtained are the same as under No-Integration. Downstream firms transfer part of their profits to the upstream firms as a payment for integrating. In our model, however, there is no need to establish such a reserve price. Full integration is observed with the difference that a prisoners dilemma is not observed. Profits for the firm that integrates first are greater than under no integration.

Even though quality investment declines and product differentiation increase, from the social viewpoint sequential vertical integration is beneficial. The firm that integrates first is the one that benefits the most. This result is obtained in spite of the fact that in our model vertical integration does not entail elimination of double marginalization.

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